

# Floristic composition of vegetation in habitats suitable for *Erigeron* × *huelsenii* (Asteraceae)

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**Abstract** – The paper provides data on the floristic composition of vegetation in anthropogenic habitats suitable for *Erigeron* × *huelsenii*, a spontaneous hybrid between the alien *E. canadensis* and native *E. acris* s. str. The study is based on 21 phytosociological relevés (vegetation plots) of 5×5 m size made in 2013–2014 in the Polish part of the Lithuanian Lakeland (north-eastern Poland) using the Braun-Blanquet method. The plots were taken on a roadside verge, a roadside slope, in abandoned sand and gravel pits, and on arable fields with grass-legume mixtures. There are 91 species of vascular plants, four species of bryophytes, three species of lichens, and one species of cyanobacteria. Vegetation is represented by populations of species typical of plant communities from the classes *Stellarietea mediae*, *Artemisietea vulgaris*, *Koelerio-Corynephoretea*, *Festuco-Brometea* and *Molinio-Arrhenatheretea*. Two floristic groups recognized from hierarchical cluster analysis and principal component analysis correspond with ruderal and segetal habitats. The study reveals that arable fields with grass-legume mixtures on sandy soils can be very suitable for *E.* × *huelsenii*.

**Keywords:** anthropogenic habitat, Braun-Blanquet method, *Erigeron acris*, *Erigeron canadensis*, invasive species, multivariate analysis, plant hybridization

## Introduction

Habitats disturbed by human activities play a major role in the process of hybridization between alien and native plant species (Vilà et al. 2000, Daehler and Carino 2001, Blair and Hufbauer 2010, Guo 2014). It has long been recognized that disturbance can bring two parental species into close proximity, increasing rates of cross-pollination and hybridization. Moreover, disturbance often creates intermediate habitats that are especially suitable for hybrids (Anderson 1948, Daehler and Carino 2001). Hybridization involving alien and native species used to be viewed as one of the indirect effects of biological invasions (Vilà et al. 2000). Nowadays, it is an impact mechanism taken into consideration in the classification of alien species (Blackburn et al. 2014). Spontaneously occurring hybrids between alien and native plants have been well-documented (Vilà et al. 2000, Daehler and Carino 2001, Bleeker et al. 2007, Lehman et al. 2014, Stace et al. 2015), and according to Pyšek et al. (2004) they must be understood as alien plant species.

In Europe, *Erigeron canadensis* L. (≡ *Conyza canadensis* (L.) Cronquist) (Asteraceae), one of the commonest alien plants of North American origin (Weaver 2001, Lambdon et al. 2008), hybridizes with a native congener *E. acris*

L. s. str. giving a hybrid known as *E.* × *huelsenii* Vatke (≡ × *Conyzigeron huelsenii* (Vatke) Rauschert). The hybrid has been reported from the United Kingdom, Belgium, Germany, the Czech Republic, Slovakia and Poland (Wurzell 1995, Šida 2000, Bleeker et al. 2007, Danihelka et al. 2012, Verloove and Lambinon 2014, Pliszko 2015, Stace et al. 2015). It is characteristically found as a single plant or in small numbers together with the parental species in disturbed areas, and is considered to be completely sterile (Stace et al. 2015). The alien parent *E. canadensis* is a species of ruderal and segetal communities of the class *Stellarietea mediae*, and the native parent *E. acris* s. str. is a species of semi-natural dry grassland communities of the classes *Koelerio-Corynephoretea* and *Festuco-Brometea* and ruderal communities of the class *Artemisietea vulgaris* (Mucina 1997, Šida 2004, Pliszko 2015). Both parental species are light-demanding plants and occur on mineral, mesotrophic, usually dry soils (Zarzycki et al. 2002). Due to its ephemeral occurrence and intermediate morphological features the hybrid is easily overlooked during floristic and ecological field surveys. In consequence, phytosociological studies on habitats suitable for *E.* × *huelsenii* have not been undertaken. In this paper we aimed to compare the floristic composition of vegetation in disturbed places in

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Poland where the spontaneous hybridization between *E. canadensis* and *E. acris* s. str. occurs.

## Materials and methods

### Study area

The study was conducted in seven newly discovered localities of *Erigeron* × *huelsenii* in the Polish part of the Lithuanian Lakeland, north-eastern Poland (On-line Suppl. Fig. 1, Tab. 1). This lowland area is located in a transitory temperate climate zone with some influence from the continental climate. In the period 1971–2000 the average annual air temperature was about 6.5 °C, and the average annual precipitation was 550–600 mm (Lorenc 2005). The native vegetation is represented mainly by nemoral forest communities with boreal and subboreal influences (Szafer and Zarzycki 1972), however, the area is highly deforested and has an agricultural character. The soils in the studied sites developed from the glacial-fluvial sands and gravels deposited during the Vistula Glaciation (Ber 1981).

### Sampling

A total of 21 phytosociological relevés (vegetation plots) of 5×5 m size were made in 2013–2014 in open anthropogenic habitats, including one plot on a sandy roadside verge, one plot on a sandy roadside slope, eight plots in abandoned sand and gravel pits, and 11 plots on sandy arable fields with grass-legume mixtures (Tab. 1). Visual estimation of cover-abundance in plots was based on the widely applied Braun-Blanquet method (Braun-Blanquet 1964, Westhoff and van der Maarel 1973). Names of taxa followed Mirek et al. (2002), Wójciak (2003), and Siemińska and Wołowski (2003). Taxonomic treatment of *Erigeron* followed the concept proposed by Greuter (2003). Names of syntaxa and diagnostic species followed Mucina (1997). Taxa were identified using morphological features given by Wójciak (2003), Rutkowski (2004), Keshari et al. (2015), and Stace et al. (2015). Geographical-historical status of vascular plants is according to Mirek et al. (2002) and Tokarska-Guzik et al. (2012). Hybrids between alien and na-

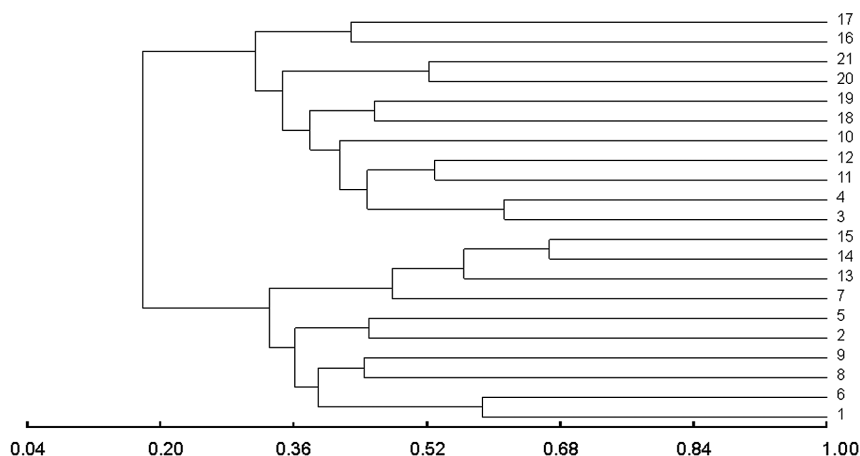
tive plant species are treated as alien species (Pyšek et al. 2004). Voucher specimens of *E.* × *huelsenii* collected during the field studies are deposited in the Herbarium of the Institute of Botany of the Jagiellonian University in Kraków (KRA).

### Data analysis

Cover-abundance values of the Braun-Blanquet scale were transformed to the numerical 1–9 scale (van der Maarel 1979). The vegetation plots were analyzed by multivariate methods. Data analyses were performed using MVSP version 3.1 (Multivariate Statistical Package) (Kovach 1999). The Jaccard similarity index was used to estimate the species composition similarity between the vegetation plots. The dendrogram was prepared using the unweighted pair group method with arithmetic mean (UP-GMA). The scatter diagram was prepared using the procedure of principal component analysis (PCA).

## Results

All vegetation plots together contain 91 species of vascular plants (excluding microspecies of the genus *Taraxacum*), four species of bryophytes, three species of lichens, and one species of cyanobacteria. There are 15 alien species and three species of uncertain geographical-historical status in the Polish flora. The plots sampled on arable fields include five species cultivated as fodder crops (grass-legume mixtures), namely *Dactylis glomerata* L., *Lolium perenne* L., *Medicago sativa* L., *Phleum pratense* L. and *Trifolium pratense* L. (On-line Suppl. Tab. 1). The number of species per plot is  $24.62 \pm 6.20$ . The cover of individual species in plots is low, including *Erigeron* × *huelsenii* and its parental species, and only in three cases it reaches 75% (i.e. *Calamagrostis epigejos* (L.) Roth, *Dactylis glomerata* and *Ceratodon purpureus* (Hedw.) Brid.). Vegetation is represented by populations of species typical of plant communities from the classes *Stellarietea mediae*, *Artemisietea vulgaris*, *Koelerio-Corynephoretea*, *Festuco-Brometea* and *Molinio-Arrhenatheretea* (On-line Suppl. Tab. 1).



**Fig. 1.** Dendrogram made on the basis of cluster analysis (unweighted pair group method with arithmetic mean and the Jaccard index) showing floristic similarity between the vegetation plots. Numbers (1–21) indicate respective relevés described in Tab. 1 and On-line Supplement Tab. 1.

**Tab. 1.** Location, date of sampling and habitat description of plots sampled for the study. According to the ATPOL cartogram method (Zając 1978) the capital letters indicate 100-km square, whereas the numbers indicate 10-km square; m.a.s.l. – meters above sea level.

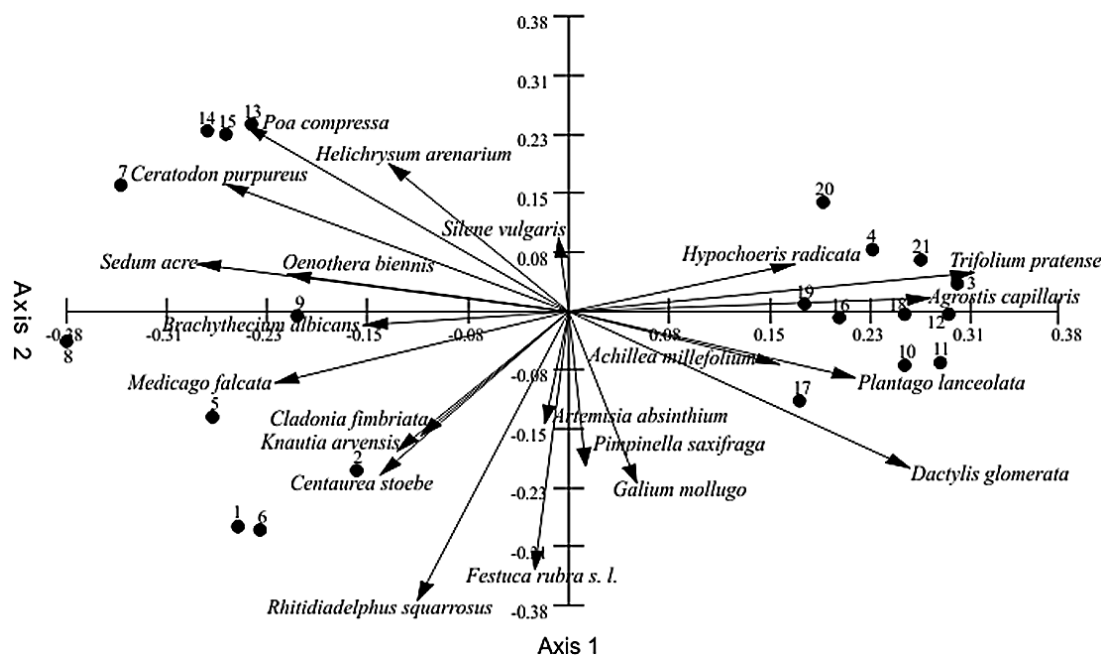
Plot no.	Locality	GPS coordinates	Altitude (m.a.s.l.)	ATPOL cartogram unit	Habitat	Date
1	Suwałki near Sobolewo	54°4' 43.8" N 22°57' 30.18" E	159	FB18	abandoned sand and gravel pit	7 August 2013
2	Filipów Czwarty	54°9' 54.24" N 22°36' 57.54" E	195	FB06	sandy roadside slope	9 August 2013
3	Filipów Pierwszy	54°9' 49.32" N 22°37' 6.84" E	185	FB06	sandy arable field with grass-legume mixture	16 August 2013
4	Filipów Pierwszy	54°9' 49.44" N 22°37' 5.4" E	186	FB06	sandy arable field with grass-legume mixture	16 August 2013
5	Kamionka Stara near Bakalarzewo	54°4' 46.2" N 22°40' 48.18" E	164	FB17	sandy roadside verge	18 August 2013
6	Suwałki near Sobolewo	54°4' 43.8" N 22°57' 25.8" E	158	FB18	abandoned sand and gravel pit	6 August 2014
7	Suwałki near Sobolewo	54°4' 44.64" N 22°57' 28.56" E	157	FB18	abandoned sand and gravel pit	6 August 2014
8	Suwałki near Sobolewo	54°4' 11.64" N 22°58' 5.88" E	159	FB18	abandoned sand and gravel pit	6 August 2014
9	Suwałki (former Żwirownia PKP)	54°6' 26.58" N 22°53' 55.8" E	173	FB08	abandoned sand and gravel pit	8 August 2014
10	Mieruniszki	54°8' 57.96" N 22°34' 19.5" E	196	FB06	sandy arable field with grass-legume mixture	10 August 2014
11	Mieruniszki	54°8' 58.26" N 22°34' 21.36" E	195	FB06	sandy arable field with grass-legume mixture	10 August 2014
12	Mieruniszki	54°9' 2.34" N 22°34' 21.24" E	196	FB06	sandy arable field with grass-legume mixture	10 August 2014
13	Suwałki near Sobolewo	54°4' 14.64" N 22°57' 57.12" E	162	FB18	abandoned sand and gravel pit	18 August 2014
14	Suwałki near Sobolewo	54°4' 14.58" N 22°58' 0.6" E	157	FB18	abandoned sand and gravel pit	18 August 2014
15	Suwałki near Sobolewo	54°4' 14.46" N 22°58' 2.04" E	158	FB18	abandoned sand and gravel pit	18 August 2014
16	Ostrowo near Pluszkiejmy	54°16' 55.26" N 22°27' 11.58" E	180	FA85	sandy arable field with grass-legume mixture	7 September 2014
17	Ostrowo near Pluszkiejmy	54°16' 56.34" N 22°27' 12.24" E	180	FA85	sandy arable field with grass-legume mixture	7 September 2014
18	Filipów Czwarty	54°10' 5.52" N 22°36' 52.02" E	195	FB06	sandy arable field with grass-legume mixture	8 October 2014
19	Filipów Czwarty	54°10' 5.82" N 22°36' 52.2" E	195	FB06	sandy arable field with grass-legume mixture	8 October 2014
20	Filipów Pierwszy	54°9' 50.16" N 22°37' 6.18" E	187	FB06	sandy arable field with grass-legume mixture	9 October 2014
21	Filipów Pierwszy	54°9' 49.32" N 22°37' 4.68" E	186	FB06	sandy arable field with grass-legume mixture	9 October 2014

From the hierarchical cluster analysis (UPGMA) and principal component analysis (PCA) two main floristic groups were clearly recognized (Figs. 1–2). These groups correspond with ruderal and segetal habitats. The plots taken on a roadside verge (5), a roadside slope (2), and in abandoned sand and gravel pits (1, 6–9, 13–15) represent a group of ruderal habitats, whereas the plots taken on arable fields with grass-legume mixtures (3, 4, 10–12, 16–21) represent a group of segetal habitats. The herb layer has a lower cover in plots sampled in ruderal habitats than those sam-

pled in segetal habitats, but the moss layer has a higher cover in ruderal than in segetal habitats. Moreover, in seven plots taken on arable fields there is no moss layer (On-line Suppl. Tab. 1).

## Discussion

Based on this study spontaneous hybridization between *Erigeron canadensis* and *E. acris* s. str. occurs in two floristically different types of anthropogenic habitats in Poland.



**Fig. 2** Scatter diagram presenting the results of principal component analysis (PCA) for the studied plots. Numbers (1–21) indicate respective relevés described in Tab. 1 and On-line Supplement Tab. 1. Selected species are represented by arrows.

These types concern ruderal and segetal areas. It has been reported that *E. × huelsenii* occurs mainly in places of a ruderal character such as sand pits, roadside verges, disused ironworks, railway areas (Wurzell 1995, Crompton and Preston 2001, Verloove and Lambinon 2014, Stace et al. 2015), but its occurrence in segetal habitats is poorly recognized. What is interesting is that the vegetation in all plots sampled in ruderal habitats represents an early stage of secondary succession where there are no tree and shrub layers, and the cover values of the herb and moss layers are generally low. Moreover, the early stage of secondary succession in these habitats can be characterized by the presence of epigeic species of cyanobacteria, lichens and bryophytes, as was pointed out by Langhans et al. (2009). In segetal habitats sampled for the study, in contrast, the process of secondary succession is hindered by the regular cutting of grass-legume crops for hay, thus there are no woody plant species. Nevertheless, many herbaceous plants can thrive in arable fields with grass-legume mixtures as weeds (Sanderson et al. 2013), especially on poor sandy soils where the canopy of cultivated plants is usually not dense or there are gaps in the canopy. The results of principal component analysis (Fig. 2) show that the group of ruderal habitats is floristically more heterogeneous than the group of segetal habitats. This can be explained by the fact that in the early stages of secondary succession, abandoned sand and gravel pits are readily colonized by various plant species typical of ruderal, grassland and meadow communities (Řehouňková and Prach 2006). In the vegetation plots sampled for the study most of the associated species with the highest constancy are light-demanding plants and occur usually on dry, mesotrophic or oligotrophic, sandy soils (e.g. *Artemisia campestris* L., *Hieracium pilosella* L. and *Sedum acre* L.), like *E. canadensis* and *E. acris* (Zarzycki et al. 2002). Wurzell (1995) suggested that persistence of *E. × huelsenii* in ruderal habitats depends on competition from more vigor-

ous wayside and wasteland perennial plants. Moreover, it appears that the changes in the light conditions caused by the overgrowth of trees and shrubs can limit the occurrence of the hybrid and its light-demanding parents, especially in abandoned sand and gravel pits where some woody plants are already present in the herb layer (i.e. *Betula pendula* Roth, *Malus domestica* Borkh., *Pinus sylvestris* L. and *Populus tremula* L.). For all of the aforementioned reasons, we assume that *E. × huelsenii* occurs in ruderal and segetal habitats due to favourable light conditions and to the presence of canopy gaps in which the hybrid seedlings can survive the competition from other plants.

In this paper the floristic composition illustrates the summer and autumn aspects of vegetation. The late time of plot sampling is a consequence of the phenology of *E. × huelsenii*. It is hard to find and identify vegetative individuals of the hybrid in spring. Besides, in the case of arable fields with grass-legume mixtures, when there is the second cutting of crops, the hybrid is visible only after regrowth. It is also worth mentioning that in plot number 17 (located in an arable field with grass-legume mixture) two spontaneous hybrids between alien and native plants were recorded, namely *E. × huelsenii* and *Solidago × niededereri* Khek, which seems to be a very unusual situation (On-line Suppl. Tab. 1).

In Poland, *E. canadensis* is treated as a nationally invasive alien species (Tokarska-Guzik et al. 2012). It is able to appear in large numbers, mainly in anthropogenic habitats, and hybridization with a native relative *E. acris* s. str. is one of its neglected impacts. Although *E. canadensis* and *E. acris* s. str. are commonly distributed in the country (Zajac and Zajac 2001), and often share habitats, the hybrid *E. × huelsenii* is rarely found (Pliszko 2015). Its rarity is a reflection of the fact that it is usually overlooked by taxonomists and ecologists during field surveys.

The present study reveals that, aside from the various ruderal habitats, arable fields with grass-legume mixtures on sandy soils can be very suitable for the hybrid between *E. canadensis* and *E. acris* s. str. However, there is a need for further observations on the persistence of *E. × huelsenii* in such specific habitats.

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